

Total Station Recording of Large Ship Structures in connection with the Excavation of Eight Ship-wrecks at the B&W Site in Copenhagen

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Excavation and recording, the concept

In August 1996, the *Copenhagen City Museum* carried out archaeological excavations at the B&W site, known as the former merchant harbour of Grønnegaard, in Copenhagen, the capital city of Denmark. A shipbuilding platform and other harbour installations were discovered, and subsequently excavated.

In August, of the same year, remains of a large carvel-built ship were uncovered and subsequently excavated, by the *Institute of Maritime Archaeology of the National Museum*. During the excavation of the wreck, several other ships were uncovered. The ships had been sunk in the harbour, and reused as caissons, for land-claiming and harbour building. A total of eight shipwrecks, dating from 1582 to 1738, were excavated at the site, through 1996 and 1997. The finds represent an archaeological "goldmine", as it is the first time in Denmark, that such large and different shipwrecks have been excavated and documented.

As the ships could not be conserved and preserved in their entirety, "preservation-by-record" was the only way to preserve the information, about renaissance shipbuilding in Denmark. The wrecks represented about 100 tons of ship-timbers, that had to be dismantled for documentation.

The ships were of a size and complexity, that required a fast and effective survey-method. The wrecks were, therefore, surveyed with a total station. This method had been used before, in Denmark, for large excavations, like, for example the Nydam excavations, for recording smaller artifacts, spread out in large scale. In connection with the B&W excavations, a new concept of recording had to be developed, as the use of a total station, for recording such large structures, had not been used before.

The method developed and used, for the B&W excavation, can be characterised as a Hybrid, between computer drafting and hand drafting, combining the best of the two methods, i.e., accuracy, precision, and speed of the computer, allied with observations and artistic drawings done in the traditional method. This newly developed, Hybrid-method, requires that the person, using the prism, have an

understanding of the construction to be recorded, in order to be able to complete the survey.

In the case of the B&W excavations, about 32,000 points were registered, providing data which could be processed to produce excavation plans, but also to give a three-dimensional picture, of the recorded vessels.

This method has also lately been used indoors for recording data on the Utrecht-ship, in January, 1998. The ship has been on display at the Central Museum in Utrecht, the Netherlands, since 1930. In connection with a reconservation program, it was surveyed, in order to provide an actual picture, of the current state of conservation, and its present shape.

The total station survey process

The process is relatively simple: a prism is used, as a large drawing pen, to record the outlines of the timbers. The prism is positioned on the edge of the structure that is to be recorded, and when the position has been recorded by the instrument, and loaded into a data-log, a following position can be recorded. The process is repeated, until the visible layer has been completely recorded. The files are then plotted out, in a chosen scale, in this case 1:20, and transferred to drafting film, by dotting the outlines of the plotted structures. After that, the drawing can be taken to the excavation, and hand-drawn. Complementary information, not recorded by the total station (such as the thickness of planks or frames), is then noted on the drawings. When the uppermost, visible level has been surveyed, it is removed, and the next layer can be cleaned, photographed, and recorded, with the total station equipment. Some wrecks consisted of up to eight different layers, with as many levels, to record.

Excavations and recording, the technology

When surveying large structures, such as ship-wrecks which have many close-laying points, due to their shape, the surveying process, data-logging and data processing should be as fast and economical as possible. With this in mind, the logistics of the method are such, that the survey of the ships at the B&W site was conducted with a SOKKIA SET 2B

total station, which can record a single measurement, every 1-2 seconds. The measurements were logged in a SDR 33, data-logging unit.

As measuring stations, a system of fixed reference points, which consisted of a series of iron tubes inserted in the ground, were established around the structures.

The points to be measured were sighted with a mini-prism, which was positioned over chosen structural elements. The accuracy of the method was calculated to be ± 1.0 cm.

All measurements were given an individual code, describing the structural element. This code was used subsequently, in the automatic processing of the data from its registration in the data-logging-unit, to the final plot.

The measurements and their codes were generated in the chart-construction system, SDRmap. The code library, in the SDR map, was defined in such a way, that identification of structural elements could be made by observation of object types (that is to say, frames, planks, keel,etc.). The files generated in the SDR map were exported to an AutoCAD drawing-program, from which the final plots were produced. The AutoCAD program produced a 3D image. However, only a plan view was plotted, which was further processed by hand.

The time taken for measuring 1,000 single points, processing, and production of the plots was approximately six hours.

This survey process is well suited for scientific publications as it produces accurate computer drafting, which, combined with hand-drafting, gives precise and lively excavation plans and cross-sections, which are the optimal result, when considering "preservation-by-record".

All Figures in CD-Rom.